DOCUMENT RESUME

ED 179 002 EA 011 961

TITLE	Energy Management. The Best of ERIC on Educational Management, Number 47.
INSTITUTION	Oregon Univ., Eugene. ERIC Clearinghouse on Educational Management.
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C.
PUB DATE	Nov 79
CONTRACT	400-78-0007
NOTE	5p.
AVAILABLE FROM	ERIC Clearinghouse on Educational Management, University of Oregon, Eugene, OR 97403 (free)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Building Design; *Building Improvement; Bus Transportation; Computer Oriented Programs; Conservation Education; Cost Effectiveness; *Energy Conservation; *Fuel Consumption; Operating Expenses; *School Buildings; *School Design; Solar Radiation; Student Transportation

ABSTRACT

The twelve items in this annotated bibliography on energy use in the schools are entries in the ERIC system. Most of the publications and articles cited highlight techniques for conserving energy in existing school buildings. Some publications center on building energy efficient schools. Other topics touched on include economy in school transportation, energy education, and solar energy. (JM)

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Number 47, November 1979

THE BEST OF ERIC

ON EDUCATIONAL MANAGEMENT

The Best of ERIC presents annotations of ERIC literature on important topics in educational management.

The selections are intended to give educators easy access to the most significant and useful information available from ERIC. Because of space limitations, the items listed should be viewed as representative, rather than exhaustive, of literature meeting those criteria.

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ERIC Clearinghouse on Educational Management

Energy Management

1 **American Association of School Administrators.** *Public Schools Energy Conservation Measures: Management Summaries.* Washington, D.C.: 1978. 20 pages. ED 164 339.

As part of the federally funded "Saving Schoolhouse Energy" project, ten representative elementary schools from across the nation underwent a "thorough and comprehensive engineering analysis" to determine areas of possible energy savings. Several "energy conserving opportunities" (ECOs) were identified at each site, and recommendations were made for actions considered cost-effective (initial investment recoverable within twelve years from the predicted energy savings).

The total projected costs of the recommendations at each site ranged from $1,000 to $80,000, with a mean expenditure of $25,000. The real surprise in this report, though, is the size of the predicted energy savings. "Preliminary projections suggest these expenditures will reduce energy consumption an average of 50 per cent across all ten sites."

The most frequent recommendations, and the ones with the quickest recovery rates, were to reduce outside air intake to minimum standards and to adjust various controls. Other suggestions included modifying the building envelope (increasing insulation and weather-stripping, decreasing glass surfaces), replacing incandescent lighting with fluorescent, modernizing and adjusting boilers and ventilation systems, and revising the occupied/unoccupied cycle.

The engineering analyses described here represent the first phase in the Saving Schoolhouse Energy project. Later phases include making the changes recommended in phase one, monitoring postmodification energy use, and disseminating the findings of the project. Brief descriptions of each school and the modifications suggested for each are contained in this report. Also included is an order form for ordering detailed reports of each school-site analysis.

2 **Askin, Ralph J.,** and others. *California School Energy Concepts, 1978.* Sacramento, California: Bureau of School Planning, California State Department of Education, 1978. 49 pages. ED 165 341.

Before the advent of mechanical temperature-control systems, buildings were necessarily designed with climate in mind. With technological advances and the availability of cheap energy, however, an arrogant disregard for nature became stylish. Now, with the energy crisis upon us, "architects are 'rediscovering' many of the techniques for climate control that have existed since the time of ancient Egypt but that were discarded or lowered in priority during the era of cheap energy." This publication discusses many of these "forgotten" techniques of building design, along with many new ideas for reducing energy consumption in new and existing school buildings.

Among the traditional variables that should be considered in building design are site selection (topography, prevailing winds, trees, other buildings), orientation, building shape, landscaping (deciduous trees for shade, evergreens for windbreaks), insulation, and color (dark roofs and walls absorb more heat). Other measures that can be taken to reduce energy consumption include the installation of solar energy systems, the use of double sets of external doors enclosing unheated vestibules, the reduction of electric usage during peak load times when rates are higher, and the installation of heat recovery systems.

Heat recovery involves redirecting "waste" heat to places where it can be used. Much heat, for example, is lost in the exhaust air. A "rotary heat wheel," which rotates slowly between the exhaust and incoming air streams, can reclaim up to 80 percent of the heat and pay for itself in a few years. Included are tables outlining recent "energy responsive" projects in schools, section drawings of some energy-efficient schools, and a fifty-entry bibliography.

3 **BRI Systems.** *Encouraging School Transportation Effective Energy Management (ESTEEM). Fuel Economy Management Handbook for Directors of Pupil Transportation; School District Administrators; Transportation Department Management.* Phoenix, Arizona: 1977. 161 pages. ED 165 317.

"Reductions in school bus maintenance and fuel costs of 40-60 percent or greater were successfully achieved" in many of the nation's school districts after they implemented energy-saving programs, states this federally financed publication. With an abundance of useful suggestions, this handbook shows how nearly every school district can cut costs in many areas of their transportation system.

In purchasing, for example, savings can be achieved by selecting the most suitable and energy-efficient equipment available. Radial tires, diesel engines, streamlined buses, and electronic ignition systems all save fuel. Fuel should be purchased by the truckload to obtain discounts, and parts should be ordered for a full year to obtain the best price. Also, advises the handbook, equipment should be matched with conditions: "purchase the smallest bus

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with the smallest engine offering the most efficiency that fulfills transportation needs."

Driver attitude is another important factor in fuel economy. The driver training program should emphasize efficient driving methods, and driver motivation should be kept high. "Post weekly or monthly vehicle and driver fuel consumption lists," recommends the handbook, and attempt to create a spirit of friendly competition among drivers. Also, post charts comparing current fuel consumption with the district's consumption goals.

Bus idling time can be reduced by planning routes to make only right-hand turns, and by avoiding bus travel during peak traffic hours. Fewer buses can be used if staggered dismissal times are eliminated, and if bicycling and walking are encouraged.

Also discussed in this wide-ranging handbook are public relations programs for energy conservation programs, student participation programs, and guidelines for monitoring energy management activities.

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4 **British Columbia Department of Education.** *Energy Conservation for Schools. 1978 Edition. Report Number 00654-78-09.* Victoria, British Columbia: 1978. 29 pages. ED 166 047.

By following the energy conservation plan outlined in this booklet, most school districts can reduce energy consumption by 20 percent. This figure is "not an exaggeration," the authors stress, but "can be attained and at a cost that would pay for itself in one to two years."

The first step is to appoint an "Energy Conservation Manager" to run the program. The energy manager could be an interested and motivated teacher, school board member, administrator, maintenance person, or even someone from outside the school system.

The energy manager should calculate the total energy consumed by each school in the district, using the three energy consumption record sheets provided in the booklet. One is for electricity consumption, another for oil and gas consumption, and the third for calculating both total energy consumption and the school's rating on an energy-use index (which corrects for differences in outside temperature).

With the information from the energy consumption record sheets, each school's energy use can be compared with the "energy consumption targets" provided in the booklet. These target figures reflect the "unit area energy consumption levels which should be attainable in a large number of schools without major capital expenditures."

The final step in this conservation program is to conduct an energy survey of the district's schools to identify areas where significant energy savings can be made. Experienced technical personnel—either from the district or from a consulting engineering firm—should conduct the survey and report findings and recommendations to the school board. Included is a list of conservation areas that the survey should cover.

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5 **Burr, Donald F.** "Creating Energy-Efficient Buildings." Paper presented at the American Association of School Administrators annual meeting, Atlanta, February 1978. 14 pages. ED 165 270.

Contrary to the popular impression, says Burr, the technology for making buildings energy-conservative is *not* twenty or thirty years in the future. Rather, that technology is available *now* and is probably the most developed area of energy conservation today.

One essential ingredient of all new building designs, says Burr, should be an energy (heat) storage system. Heat storage systems can use water, rock, or eutectic salts as their storage medium. Electrical energy can be purchased at night, when rates are much cheaper, and used to heat the rock, water, or salt for the next day's heating needs.

A water storage system is attractive because it can be linked directly to a hydronic (water-based) heating/cooling system in the building. Such a system can also be connected directly with roof-mounted solar energy collectors.

In most high schools, about 25 percent of all energy consumed is used to heat domestic hot water, primarily for showers. But about 80 percent of this heat can be reclaimed by collecting the waste water in an insulated storage tank and passing cold water through closed pipes in the tank.

Another "water idea" discussed by Burr is the use of an "on-site well with heat pump system." If ground water is available, it can often be circulated through a heat pump to help heat the building in winter and cool it in summer. Two wells are needed, says Burr, one for pumping water up, and the other for pumping the heated or cooled water back down (to minimize impact on the water table).

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6 **California State Department of Education.** *Energy and Water: Conservation Suggestions for California's Elementary and Secondary Schools.* Sacramento, California: 1977. 27 pages. ED 166 031.

The two keys to increasing energy conservation as outlined in this booklet are wise facility and equipment management and an energy education program.

Energy education should be designed to help students and teachers "develop the skills, knowledge, and attitudes they need to

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3. Voluntary Truck and Bus Fuel Economy Program, U.S. Dep't. of Energy, Washington, D.C. 20461. Free.
4. EDRS. Specify ED 166 047. MF $0.83. PC $3.32.
5. EDRS. Specify ED 165 270. MF $0.83. PC $1.82.
6. California State Dep't. of Education, 721 Capitol Mall, Sacramento, CA 95814. Free.
7. Council of Educational Facility Planners, Int'l., 29 West Woodruff Ave., Columbus, OH 43210. $27.50 nonmembers, $25.00 CEFP members.
8. National Technical Information Service (NTIS), U.S. Dep't. of Commerce, 5285 Port Royal Rd., Springfield, VA 22161. MF $3.00, PC $6.00.
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use energy resources wisely." An energy education program, however, should not be simply an "add-on" to the curriculum. Instead, it should be incorporated into the instruction of many subjects, including social studies, science, home economics, and mathematics. To help in implementing such a program, several sources of developed curriculum material and "teacher kits" are listed.

Since each school building is unique in both design and environmental setting, each school must be looked at individually to detect potential areas for energy savings. There are some steps, however, that all schools can take to increase their energy efficiencies. For example, roofs and exterior walls that are painted with a light, highly reflective color will reduce heat gain from the sun, as will shade trees around the building. Exterior glass areas can be reduced to the minimum necessary for "visual relief" and replaced with insulated walls. And incandescent lights can be replaced with fluorescent or other high-efficiency fixtures.

7 **Council of Educational Facility Planners, International.** *Energy Sourcebook for Educational Facilities: An Authoritative and Comprehensive Sourcebook for the Design and Management of Energy Efficient Educational Facilities.* Columbus, Ohio. 1977. 275 pages. ED 147 996.

About one-third of all energy used in the United States is consumed in operating buildings, and educational buildings are the largest group of institutional buildings. Thus, "in schools alone, the potential for saving our finite resources is immense," states this comprehensive publication.

An initial unit discusses the development of an energy management plan for local school districts. An "Energy Management Committee" should first be formed to fulfill policy-making responsibilities for the program. Next, an "Energy Conservation Team" should be appointed and should include building principals; teacher, parent, and student representatives; maintenance and transportation supervisors; and outside energy consultants. The team "should have operational authority over all aspects of energy management" and should be directly responsible to the policy committee. After appropriate inservice training, the team should analyze school energy use and then determine appropriate goals and activities.

The next two units discuss methods of collecting energy data and auditing energy use in the district. Extensive checklists, energy data forms, and illustrative graphs and charts are provided. Three auditing methods are presented: the "mini-audit," consisting of a one- to two-hour inspection by energy specialists; the "maxi-audit," a comprehensive examination of energy-use patterns by an engineering consultant; and the Public Schools Energy Conservation Service (PSECS) audit method, which uses a computer program to simulate energy-use patterns in school buildings.

Other units cover detailed conservation measures that schools can take, contracting for outside professional services, case studies in energy conservation in school districts, public relations programs, cost-benefit analyses for conservation programs, one state's energy conservation plan, and the energy policy of the CEFP/I.

8 **Department of Energy.** *Energy Audit Workbook for Schools.* Washington, D.C.: Office of State and Local Programs and Office of State Grant Programs. 1978. 88 pages. ED 164 284.

"In a typical school," states this U.S. Department of Energy publication, "it is possible to save as much as 15% of utility costs through common sense actions without any appreciable capital expenditure." With a wealth of examples, checklists, and suggestions, the booklet shows how these savings can be achieved, as well as how *more* money and energy can be saved after wise investment in energy-efficient facilities and equipment.

The first chapter is a long checklist of simple procedural changes that can be implemented for little or no cost. Suggestions include the removal of unnecessary lights, the reduction of the hot water temperature to 110-120° F, and the judicious control of building temperature. The 144 practical suggestions are conveniently organized under important energy subheads, such as space heating, boiler use, air conditioning, ventilation, lighting, and kitchens.

The second chapter, which makes up the bulk of this workbook, outlines detailed step-by-step procedures for both analyzing energy use and computing the potential savings of particular energy-saving measures. Instructions are provided for filling out a removable "Energy Management Form" using electric and fuel bills as well as weather information.

Nine specific conservation "problems" are presented with a fill-in-the-blanks format. An accompanying example illustrates the computations.

9 **Downey, Gregg W.** "Some Sunshine for Your Fiscal Life: Solar Energy Schools May Not Be As Far Off or As Blue Sky As We've Thought." *American School Board Journal* 164, 8 (August 1977), pp. 56-60. EJ 164 144.

"Most schools are naturally suited for the installation of solar equipment," states Downey, because they are generally well constructed, have flat roofs suitable for solar collectors, and have their peak energy demands during daylight hours—thus lessening energy storage requirements. Already, many schools across the country are using solar energy for water heating, space heating, and space cooling.

One solar energy firm estimates that 15 to 30 square feet of collectors are needed for each 100 square feet of building floor space. And cost quotes, says Downey, range from $6 to $20 per square foot, including installation. Thus, solar installation is fairly expensive; however, the operating costs for solar are much lower than for fuel-fired systems, so investment costs can be recouped after a few years.

For example, the school board of Florida (New York) commissioned a feasibility study to determine ways to cut down energy costs in an aging school building serving about four hundred students. The report suggested retrofitting the building to decrease heat loss and installing a solar heating system for a total cost of $80,000. With a projected fuel savings of 35 percent per year, the investment could be recouped by 1986, said the report, and even sooner if fuel prices continue to rise.

10 **Kerns, Marilyn.** *Energy Conservation: An Examination of Energy Conservation Mechanisms As They Relate to School Districts in Region XI.* St. Paul: Educational Cooperative Services Unit, University of Minnesota, 1977. 68 pages. ED 164 297.

The first step a district can take to save energy is to develop a districtwide energy conservation plan. To help in this process, Kerns outlines two recently developed energy management plans: the Total Educational Energy Management (TEEM) approach, developed by the Colorado Department of Education, and the program developed by the Council of Educational Facility Planners, International (CEFP/I).

In both approaches, the working unit of the plan is an energy conservation committee, whose membership should include most or all of the following: district energy manager; superintendent; building principals; maintenance and transportation supervisors; business manager; energy consultants; utility company representatives; and community, teacher, and student representatives. In the TEEM model, the energy committee sets objectives, determines strategies and energy-audit methods, and arranges consultations with outside experts. Then building-level task forces are developed to implement the plans.

In the CEFP/I model, the programs and activities are both planned and implemented by the committee. The task committee reports directly to an energy policy committee, composed of board members, appropriate central office administrators, and energy experts.

The first action taken by an energy conservation committee might be to conduct an energy audit of the district's schools. She describes the same three auditing methods mentioned in CEFP/I's Energy Sourcebook. Also included are extensive checklists of energy conservation measures that schools can take.

11 **Nanni, Robert.** "Plugging the Energy Drain." *School Business Affairs*, 44, 2 (February 1978), pp. 33-34. EJ 173 511.

Using a small computer system, two high schools in Illinois have considerably reduced their power consumption, says Nanni. The computer is responsible for shutting off and on the thirty-eight air-handling units in the two schools, which vary considerably in horsepower and areas served.

"The computer-controlled on/off cycle intervals vary according to the time of day, the day of the week, and the season of the year," says the author. During school hours, the computer turns each fan off for six minutes of each half hour. After 4 P.M., the fans are turned off for fifteen minutes of each half hour. Between 9 P.M. and 5 A.M., the fans remain off.

Every half hour, the computer provides a print-out showing which air units are on, as well as the following electrical-usage information: power consumption totals, kilowatt-hour usage, the peak demand limit, and "the plus or minus percentage of actual consumption versus demand limit." When electrical usage approaches the utility's demand limit (where excessive demand-cost penalties are incurred), the computer compensates by shutting down fans for longer periods of time.

Since the computer control system is "open-ended," the district is considering expanding its use to other power management areas, such as controlling the mercury vapor lamps in the parking lots and monitoring the school bus gasoline pumps.

12 **Tiedeman, Thomas V.** *An Energy Conservation Retrofit Process for Existing Public and Institutional Facilities.* Washington, D.C.: Public Technology, Inc., 1977. 127 pages. ED 161 763.

Can modifying existing buildings really result in substantial energy savings? According to Federal Energy Administration (FEA) estimates, "a building owner may expect to save 10%-20% in energy use without any initial cost, another 10% with minimal first costs, and 10%-20% more with an investment which can be paid back by savings in three to ten years."

In this publication, Tiedeman concentrates on those modifications that require some capital expenditure. Even if the funds available for retrofit are small, he emphasizes, viable conservation options are likely to exist.

The first phase in the retrofitting process is to determine the most energy inefficient facilities by studying past and current energy consumption patterns. Tiedeman presents three methods for conducting such a study, ranging from a "rough estimate" method to the sophisticated component-by-component method developed by the FEA.

When the facilities most appropriate for retrofitting have been identified, each should undergo a "detailed engineering and architectural study of potential energy conservation modifications." Detailed instructions for choosing consulting firms and evaluating their qualifications are included.

Once the retrofitting has been completed, it is important to monitor the results of the project to determine whether savings have actually been achieved. An added benefit of monitoring is that it becomes easier to identify whether retrofitting should be initiated on similar buildings in the future.

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Besides processing documents and journal articles, the Clearinghouse prepares bibliographies, literature reviews, monographs, and other interpretive research studies on topics in its educational area.

This publication was prepared pursuant to a contract with the National Institute of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Prior to publication, the manuscript was submitted to the Association of California School Administrators for critical review and determination of professional competence. This publication has met such standards. Points of view or opinions, however, do not necessarily represent the official view or opinion of either the Association of California School Administrators or the National Institute of Education.

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